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British Standards Institution
Report

No. 24—1911. (Part I.).

British Engineering Standards Association.

(Incorporated 1918.)

Formed in 1901 as The Engineering Standards Committee
by
The Institution of Civil Engineers.
The Institution of Mechanical Engineers.
The Institution of Naval Architects.
The Iron and Steel Institute.
The Institution of Electrical Engineers.

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BRITISH STANDARD SPECIFICATIONS FOR

RAILWAY ROLLING STOCK MATERIAL.

PART I.

LOCOMOTIVE, CARRIAGE AND WAGON AXLES.

(REVISED DECEMBER, 1911.)

LONDON:
Published for the Association by CROSBY LOCKWOOD & SON,
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November, 1918.

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No. 24—1911. (PART I.).

British Engineering Standards Association.

(Incorporated 1918.)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE
BY
THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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PART VI. Steel Plates, Angles, etc., and Rivets for Locomotives, Carriages and Wagons.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

MAIN COMMITTEE.

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SIR MAURICE FITZMAURICE, C.M.G. (*Vice-Chairman*).

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DR. J. H. T. TUDSBERY (*Hon. Secretary*).

MR. C. LE MAISTRE (*Secretary*).

MR. CHARLES DRESSER (*Assistant Secretary*).

---

†Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February, 1918.

No. 24—1911. (Part I.).

BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are lists of the Members of the Sectional Committee on Locomotives and its Sub-Committees and of the Sectional Committee on Railway Rolling Stock Underframes.

SECTIONAL COMMITTEE ON LOCOMOTIVES.

December, 1911.

Chairman, SIR DOUGLAS FOX.

War Office, *Major A. G. Stevenson, D.S.O., R.E.

India Office, Mr. A. Brereton, C.S.I.

Crown Agents for the Colonies, Mr. G. L. Eyles, C.M.G. ; Mr. Ashton M. Heath.

Locomotive Manufacturers' Parliamentary Association: Mr. W. Lorimer (*North British Locomotive Co., Ltd.*); † Mr. Hugh Reid (*North British Locomotive Co., Ltd.*); **Mr. T. P. Reay (*Kitson & Co., Ltd.*).

Railway Companies' Association: Mr. J. A. F. Aspinall (*Lancashire and Yorkshire Railway*); Mr. J. F. McIntosh, M.V.O. (*Caledonian Railway*).

Association of Railway Locomotive Engineers: Mr. G. J. Churchward (*Great Western Railway*) ; ‡ Mr. G. H. Hughes (*Lancashire and Yorkshire Railway*).

Steel Ingot Makers' Association: § Mr. Maxmilian Mannaberg (*Frodingham Iron and Steel Co., Ltd.*).

Steel Founders' Association of Great Britain: Sir Robert Hadfield (*Hadfield's Steel Foundry Co., Ltd.*).

Mr. F. Wolley-Dod (*Chairman of the Calcutta Conference, 1901*).

**Sir John Wolfe Barry, K.C.B. ; Mr. G. Ainsworth (*Consett Iron Co., Ltd.*); **Mr. H. C. Arbuthnott (*Taylor Bros. & Co., Ltd.*); Mr. J. Hartley Bibby (*John Bibby, Sons & Co.*); Mr. D. Cassels (*Steel Company of Scotland, Ltd.*); Mr. W. Collingwood (*Vulcan Foundry, Ltd.*); Mr. J. M. Dobson (*Hawkshaw & Dobson*); || Mr. J. Duncan Elliot (*Carruthers & Elliot*); Mr. F. C. Fairholme (*Thomas Firth & Sons, Ltd.*); Mr. C. N. Goodall (*Robert Stephenson & Co., Ltd.*); Mr. E. Greg, Jnr. (*Nasmyth Wilson & Co., Ltd.*); Mr. Cyril Hitchcock (*Sir George Bruce & White*); ¶ Mr. A. F. Halstead (*Beyer, Peacock & Co., Ltd.*); Mr. Bradford Leslie (*A. J. Barry & Leslie*); Mr. Edward Mills (*Williams Foster & Co.,* and *Pascoe, Grenfell & Sons, Ltd.*); **Mr. F. E. Robertson, C.I.E. (*Rendel & Robertson*); Mr. Frederick Tomlinson (*Broughton Copper Co., Ltd.*); Mr. Seymour B. Tritton (*Rendel & Robertson*) ; Mr. J. N. Vickers (*Vickers, Ltd.*); Mr. Robert White (*Sir George Bruce & White*).

---

* Succeeded Major T. H. Cochrane, M.V.O., R.E., October, 1909.

† Succeeded Mr. J. F. Robinson, January, 1910.

‡ Succeeded Mr. James Holden, June, 1908.

§ Succeeded Mr. F. W. Dick, July, 1909.

|| Succeeded Mr. John Carruthers, July, 1910.

¶ Succeeded Mr. A. S. Jameson, June, 1911.

** Deceased.

SECTIONAL COMMITTEE ON RAILWAY ROLLING STOCK UNDERFRAMES.

December, 1911.

Chairman, SIR DOUGLAS FOX.

Crown Agents for the Colonies, Mr. G. L. Eyles, C.M.G. ; Mr. Ashton M. Heath.

Mr. D. Bain (*Midland Railway*) ; Mr. Lincoln Chandler (*Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd.*); Mr. Thomas G. Clayton (*late Midland Railway*); Mr. Brodie Henderson (*Livesey, Son & Henderson*) ; †Mr. G. A. Hobson (*Sir Douglas Fox & Partners*) ; * Mr. H. D. Earl (*London & North Western Railway*) ; †Mr. F. E. Robertson, C.I.E. (*Rendel & Robertson*) ; Mr. H. J. Skelton (*H. J. Skelton & Co.*).

* Succeeded Mr. C. A. Park, June, 1910.

† Deceased.

LOCOMOTIVE SUB-COMMITTEES.

December, 1911.

SUB-COMMITTEE ON TYRES, AXLES AND SPRINGS.

Chairman, Mr. G. J. Churchward.

†Mr. H. C. Arbuthnott; Mr. W. J. Armitage ; Mr. D. Bain ; Mr. Lincoln Chandler ; Mr. F. C. Fairholme ; Mr. Albert Good ; Mr. Richard Halstead ; Mr. Ashton M. Heath ; Mr. C. Hitchcock ; Mr. Henry Steel, Jnr. ; Dr. W. C. Unwin.

SUB-COMMITTEE ON LOCOMOTIVE STEEL PLATES.

Chairman, Mr. W. Lorimer.

Mr. G. Ainsworth ; Mr. D. Cassels ; Mr. Maxmilian Mannaberg ; †Mr. T. P. Reay ; Dr. W. C. Unwin.

SUB-COMMITTEE ON COPPER AND ITS ALLOYS.

Chairman, Mr. J. F. McIntosh, M.V.O.

Mr. J. Hartley Bibby ; Mr. Edward Mills ; Mr. Hugh Reid ; Mr. Frederick Tomlinson.

† Deceased.

PREFACE TO FIRST EDITION.

The subject of the Standardisation of Locomotives was first raised at a meeting of the Main Committee on January 14th, 1902, when Sir John Wolfe Barry recorded interviews he had had with Lord George Hamilton and other officials of the India Office with regard to this subject, and it was agreed that evidence should be collected. On March 4th, 1902, the Main Committee sat to hear evidence on the subject, and this being in favour of proceeding, a Sectional Committee on Locomotives was formed under the Chairmanship of Sir Douglas Fox.

The Sectional Committee on Locomotives held their first meeting on May 30th, 1902, when the following Sub-Committees were formed:—

Name.	*Chairman.*
Locomotive Steel Plates . .	Mr. W. Lorimer.
Tyres, Axles, and Springs .	Mr. W. Lorimer.
Copper and its Alloys . . .	Mr. W. Dean. (Succeeded by Mr. J. F. McIntosh.)

A number of meetings of the Sub-Committees have been held, and the Report in its present form was adopted by the Sectional Committee on Locomotives at their meeting held on March 23rd, 1906.

The Sectional Committee on Locomotives desire to place on record their appreciation of the services rendered by the Association of Railway Locomotive Engineers through their representatives on the Committee.

In many instances, somewhat divergent opinions have had to be reconciled, and this has only been rendered possible by accepting the view that the Standard Specifications will be considered from time to time as occasion requires, and the Sectional Committee are desirous of making this point clear when submitting their Report.

To meet the various needs of the Home, Indian, and Colonial requirements, the Committee have in many cases included similar Specifications—one with, and the other without, a Chemical Analysis —in order that those who do not desire to specify a Chemical Analysis can still use a Standard Specification

The Sectional Committee on Railway Rolling Stock Underframes, under the same Chairman, was appointed by the Main Committee at their meeting on July 16th, 1901. Having, in conjunction with the Sectional Committee on Sections used in Shipbuilding and that on Bridges and General Building Construction, completed the drawing up of a list of Standard Sections, the preparation of a Standard Specification was proceeded with. For convenience of publishing, this Specification is included in the present volume, and constitutes Specification No. 17.*

The Specifications were considered by the Sectional Committee on Underframes at a meeting held in conjunction with the Sectional Committee on Locomotives on March 23rd, 1906, and finally adopted by the Sectional Committee on Locomotives at their meeting held on July 12th, 1906.

The Reports of the two Sectional Committees, which are contained in the present volume, were approved by the Main Committee at the meeting held on July 26th, 1906.

DOUGLAS FOX,

Chairman of the Sectional Committees on Locomotives and Railway Rolling Stock Underframes.

PREFACE TO SECOND EDITION.

Since the issue of the first revision in June, 1907, the Committees on Locomotives and Railway Rolling Stock Underframes have from time to time had brought before them points which have arisen in connection with the use of the Standard Specifications, and the present issue of Report No. 24 embodies the Committee's decisions in regard to these. Some of the more important modifications to the Specifications are as follows :—

1. The prohibition of a re-test in the case of failure under the falling weight test for Axles.
2. The option of a bend test in the Specification for Carriage and Wagon Axles (without analysis) if there is any question in the mind of the Engineer as to the Axle having satisfactorily passed the falling weight test.
3. The deletion of the Specification (without analysis) for Locomotive Tyres.
4. The deletion of Class **B** tyres (42-48 tons per square inch) from the Specification (with Analysis) for Locomotive Tyres.

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* Now published in Part VI. of Report No. 24—1911.

5. The addition of Class **C** tyres (50-55 tons per square inch) to the Specification (without Analysis) for Carriage and Wagon Tyres.

6. The deletion of Class **A** tyres (35-40 tons per square inch) from the Specification (without Analysis) for Carriage and Wagon Tyres.

7. The insertion in the Tyre Specifications of a formula for the deflection under the falling weight test based upon the thickness and internal diameter of the tyre in place of that previously employed which was based upon the internal diameter only.

8. The division of the Specifications for Laminated Springs and Spring Steel into separate Specifications, dealing respectively with Spring Steel and with the finished Springs.

   With a view of restricting the tensile stress on the plates of the finished Spring under the scragging test to a figure somewhat below 70 tons per square inch, a definite deflection, depending upon the length of the top plate of the Spring and thickness of the thickest plate, is now specified, and a table of the required deflections is inserted in the Specification.

9. The addition of a further class of Forgings (Class **E**) to the Forging Specification.

10. The reduction of the tensile strength of Rivet Bars to 24-28 tons per square inch.

The Committee have had representations made to them with regard to the use of the term "*Elastic Limit*" in the Axle and Forging Specifications, and this term has now been altered to "*Yield Point*," a definition of this latter term being added as a note to the Specifications in which this term is employed.

The Committee recommend that in specifying materials to any of the Specifications contained in this Report, both the Specification number and the number of the Report be quoted, in order to obviate confusion with other Reports of the Committee.

The Report in its present form was approved by the Sectional Committees concerned in October, 1911, and by the Main Committee on December 6th, 1911.

DOUGLAS FOX,

Chairman of the Sectional Committees on Locomotives and Railway Rolling Stock Underframes.

Reference to be quoted.

Report No. 24
Specification No. 1-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
LOCOMOTIVE CRANK AXLES.
(WITH ANALYSIS.)
(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Crank Axles shall be manufactured from the highest quality of Steel made from the best selected material by the Acid Open Hearth process, and must not show on analysis more than 0·035 per cent. of Sulphur or of Phosphorus.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Crank Axles must be free from defects of any kind and accurately finished to the prescribed dimensions.

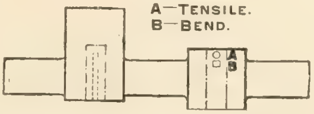
Branding.

3. The Crank Axles shall be distinctly stamped, when hot, on the web nearest the top of the ingot with such brands as the Engineer (or the Purchaser) may require.

Test Pieces.

4. *Crank Axles having Flat or Oval Webs:*—Test pieces shall be machined cold from between each pair of webs of each Crank Axle and taken in the direction indicated in the sketch. The Cranks shall be slotted or sawn.

Crank Axles having Round Webs:—Test pieces shall be taken from pieces forged on each end of each Crank Axle, and having the same diameter as the Wheel-Seat.



In either case the test pieces shall not be detached from the Axles until stamped by the representative of the Engineer (or of the Purchaser).

Mechanical Tests.

5. Test pieces machined from the Axles as above must withstand the following tests without further re-heating or any other manipulation whatever.

Tensile Tests.

6. A Standard Test Piece **C** or **D** (*see* Appendix, page 37) must show a tensile breaking strength of not less than 30 tons per square inch, with an elongation of not less than 25 per cent., or if the Crank Axle be oil-treated not less than 35 tons per square inch, with an elongation of not less than 20 per cent. The yield point* in either case must be not less than 50 per cent. of the ultimate tensile strength.

Number of Tensile Tests.

7. *Crank Axles having Flat or Oval Webs* :—One tensile test shall be taken from between each pair of Webs of each Crank Axle.

Crank Axles having Round Webs :—One tensile test shall be taken from each end of each Crank Axle.

Cold Bend Test.

8. A test piece 9 inches long, $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, machined from the Crank Axles as in Clause 5, must withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture.

Number of Cold Bend Tests.

9. *Crank Axles having Flat or Oval Webs* :—One cold bend test shall be taken from between each pair of Webs of each Crank Axle.

Crank Axles having Round Webs :—One cold bend test shall be taken from each end of each Crank Axle.

Fatigue Test.

10. As an alternative to the cold bend test, the test piece referred to in Clause 8 may be placed upon bearings having a clear span of 6 inches, resting on a solid foundation, and must withstand, without fracture, 20 blows from a weight of 1,120 lbs., having a rounded end of $1\frac{1}{4}$ inch radius, falling 6 inches. The test piece shall be reversed after the first and every alternate blow. The fall shall then be increased to 12 inches, and the test continued until fracture occurs.

---

* The yield point shall, for the purpose of this Specification, be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers ; or at which, when the load is increased at a moderately fast rate, there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Re heating or Oil-treating.

11. All Crank Axles shall be either re-heated or oil-treated.

Inspection.

12. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

Testing Facilities.

13. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No.	**24**
Specification No.	**1a-1911**

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
LOCOMOTIVE CRANK AXLES.

(WITHOUT ANALYSIS.)

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Crank Axles shall be manufactured from the highest quality of Steel made from the best selected material by the Acid Open Hearth process.

Freedom from Defects.

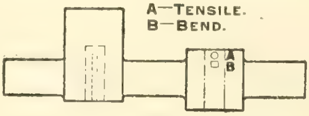
2. The Crank Axles must be free from defects of any kind and accurately finished to the prescribed dimensions.

Branding.

3. The Crank Axles shall be distinctly stamped, when hot, on the web nearest the top of the ingot with such brands as the Engineer (or the Purchaser) may require.

Test Pieces.

4. *Crank Axles having Flat or Oval Webs* :—Test pieces shall be machined cold from between each pair of webs of each Crank Axle and taken in the direction indicated in the sketch. The Cranks shall be slotted or sawn.



Crank Axles having round Webs :—Test pieces shall be taken from pieces forged on each end of each Crank Axle and having the same diameter as the Wheel-Seat.

In either case the test pieces shall not be detached from the Axles until stamped by the representative of the Engineer (or of the Purchaser).

Mechanical Tests.

5. Test pieces machined from the Axles as above must withstand the following tests without further re-heating or any other manipulation whatever.

Tensile Test.

6. A Standard Test Piece **C** or **D** (see Appendix, page 37) must show a tensile breaking strength of not less than 30 tons per square inch, with an elongation of not less than 25 per cent., or if the Crank Axle be oil-treated not less than 35 tons per square inch, with an elongation of not less than 20 per cent. The yield point* in either case must be not less than 50 per cent. of the ultimate tensile strength.

Number of Tensile Tests.

7. *Crank Axles having Flat or Oval Webs* :—One tensile test shall be taken from between each pair of webs of each Crank Axle.

Crank Axles having Round Webs :—One tensile test shall be taken from each end of each Crank Axle.

Cold Bend Test.

8. A test piece 9 inches long, $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, machined from the Crank Axles as in Clause 5, must withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture.

Number of Cold Bend Tests.

9. *Crank Axles having Flat or Oval Webs* :—One cold bend test shall be taken from between each pair of webs of each Crank Axle.

Crank Axles having Round Webs :—One cold bend test shall be taken from each end of each Crank Axle.

Fatigue Test.

10. As an alternative to the cold bend test, the test piece referred to in Clause 8 may be placed upon bearings having a clear span of 6 inches, resting on a solid foundation, and must withstand, without fracture, 20 blows from a weight of 1,120 lbs., having a rounded end of $1\frac{1}{4}$ inch radius, falling 6 inches. The test piece shall be reversed after the first and every alternate blow. The fall shall then be increased to 12 inches, and the test continued until fracture occurs.

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* The yield point shall for the purpose of this Specification be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers ; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Re-heating or Oil-treating.

11. All Crank Axles shall be either re-heated or oil-treated.

Inspection.

12. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

Testing Facilities.

13. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No.	**24**
Specification No.	**2-1911**

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
LOCOMOTIVE STRAIGHT AXLES.
(WITH ANALYSIS.)

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Axles shall be manufactured from the highest quality of Steel made from the best selected material by the Acid Open Hearth process, and must not show on analysis more than 0·035 per cent. of Sulphur or of Phosphorus.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Axles must be free from defects of any kind and accurately finished to the prescribed dimensions.

Branding.

3. The Axles shall be distinctly stamped when hot, as far from the centre as practicable, with such brands as the Engineer (or the Purchaser) may require, and in such a manner that these marks shall be legible when the Axles are worn out. When Axles are machined the brands shall be re-stamped cold on one end.

Mechanical Tests.

4. Extra Axles for testing in the manner described in Clauses 5, 6 or 7 shall be provided by the Manufacturer, at his own expense, at the rate of two per cent. of the Axles ordered under the contract, but, except as provided below, one extra Axle shall be provided from each cast, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Axles as he may think proper to the extent of such percentage or extra number. The Axles tested shall be held to represent correctly the quality of the casts from which they were made. In the case of a less number than 15 Axles being asked for under the contract, or less than 15 being made from each cast, the Manufacturer may either (1) provide an extra Axle for testing, or (2) leave a piece on each Axle of the same diameter as the forged end of the Axle, to enable the representative of the Engineer (or of the Purchaser) to stamp one such piece from which test pieces may be cut for the

Reference to be quoted.

Report No. 24
Specification No. 2-1911

tensile test and cold bend test specified in Clauses 6 and 7. After selection of Axles for testing each test Axle must comply with the following tests, without further re-heating or any other manipulation whatever, either of the Axle selected for testing, or of any portion cut therefrom to furnish the test pieces.

Falling Weight Test.

5. The Axle shall be placed upon bearings resting on a block of metal of not less than 5 tons weight supported on a rigid concrete or other solid foundation, and must withstand, without fracture, five blows from a falling weight of 2,240 lbs., as specified below.

The Axle shall be turned after the first and third blow, and shall be broken after testing, both in the centre and at the journals.

Diameter of Axle at Centre.	Number of Blows.	Height of Fall, in feet.	Distance between Points of Support.*	
			Ft	Ins.
Under 4 inches	5	16	3	0
4 ins. and under 4¼ ins. ...	5	18	3	6
4¼ ins. and under 4½ ins. ...	5	20	3	6
4½ ins. and under 4¾ ins. ...	5	22	3	6
4¾ ins. and under 5 ins. ...	5	24	3	6
5 ins. and under 5¼ ins. ...	5	24	4	0
5¼ ins. and under 5½ ins. ...	5	28	4	0
5½ ins. and under 5¾ ins. ...	5	28	4	6
5¾ ins. and under 6 ins. ...	5	32	4	6
6 ins. and over	5	35	5	0

Tensile Test.

6. A Standard Test Piece **C** or **D** (*see* Appendix, page 37), machined cold from one end of each Axle tested as above, must show a tensile breaking strength of 35 to 40 tons per square inch, with an elongation of not less than 25 per cent. with 35 tons and 20 per cent. with 40 tons; the sums of the intermediate tensile breaking strengths and corresponding elongations being not less than 60. The yield point* must be not less than 50 per cent. of the ultimate tensile strength.

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* In cases where the length of the Axle does not permit of these distances being adhered to, the distance between the points of support shall be as great as possible.

Cold Bend Test.

7. A test-piece 9 inches long and $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, must withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture.

N.B.—This test will be taken only when a less number than 15 Axles are ordered and the falling weight test (Clause 5) has not been carried out.

Additional Tests before Rejection.

8. In the event of the Axle selected for testing not satisfying the requirements of the tensile or bend tests, and the fractured test piece indicating that the result does not fairly represent the bulk of the Axles, the representative of the Engineer (or of the Purchaser) may at his discretion, and at the expense of the Manufacturer, take two more test pieces from the same Axle for repeating the test under which failure occurred. The Axles will be accepted if the results of the repeat tests are satisfactory.

Should the Axle fail in the falling weight test, the cast which the Axle represents shall be rejected.

Independent Tests.

9. If the Engineer (or the Purchaser) desires to make independent tensile or other tests of the material, the broken pieces of any of the Axles tested shall be placed at his disposal for the purpose, free of charge.

Re-heating or Oil-Treating.

10. All Axles shall be either re-heated or oil-treated.

Inspection.

11. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

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* The yield point shall for the purpose of this Specification be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Testing Facilities.

12. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
LOCOMOTIVE STRAIGHT AXLES.
(WITHOUT ANALYSIS).

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Axles shall be manufactured from the highest quality of Steel made from the best selected material by the Acid Open Hearth Process.

Freedom from Defects.

2. The Axles must be free from defects of any kind and accurately finished to the prescribed dimensions.

Branding.

3. The Axles shall be distinctly stamped when hot, as far from the centre as practicable, with such brands as the Engineer (or the Purchaser) may require, and in such a manner that these marks shall be legible when the Axles are worn out. When Axles are machined the brands shall be re-stamped cold on one end.

Mechanical Tests.

4. Extra Axles for testing in the manner described in Clauses 5, 6, or 7 shall be provided by the Manufacturer, at his own expense, at the rate of two per cent. of the Axles ordered under contract, but, except as provided below, one extra Axle shall be provided from each cast, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Axles as he may think proper to the extent of such percentage or extra number. The Axles tested shall be held to represent correctly the quality of the casts from which they were made. In the case of a less number than 15 Axles being asked for under the contract, or less than 15 being made from each cast, the Manufacturer may either (1) provide an extra Axle for testing or (2) leave a piece on each Axle of the same diameter as the forged end of the Axle, to enable the representative of the Engineer (or of the Purchaser) to stamp one such piece from which test pieces may be cut for the tensile test and cold bend test specified in Clauses

6 and 7. After selection of Axles for testing each test Axle must comply with the following tests, without further re-heating or any other manipulation whatever, either of the Axle selected for testing, or of any portion cut therefrom to furnish the test pieces.

Falling Weight Test.

5. The Axle shall be placed upon bearings resting on a block of metal of not less than 5 tons weight supported on a rigid concrete or other solid foundation, and must withstand, without fracture, five blows from a falling weight of 2,240 lbs., as specified below.

The Axle shall be turned after the first and third blow, and shall be broken after testing, both in the centre and at the journals.

Diameter of Axle at centre.	Number of Blows.	Height of Fall, in feet.	Distance between Points of Support.*	
			Ft.	Ins.
Under 4 inches	5	16	3	0
4 ins. and under 4¼ ins. ...	5	18	3	6
4¼ ins. and under 4½ ins. ...	5	20	3	6
4½ ins. and under 4¾ ins. ...	5	22	3	6
4¾ ins. and under 5 ins. ...	5	24	3	6
5 ins. and under 5¼ ins. ...	5	24	4	0
5¼ ins and under 5½ ins. ...	5	28	4	0
5½ ins. and under 5¾ ins. ...	5	28	4	6
5¾ ins. and under 6 ins. ...	5	32	4	6
6 ins. and over	5	35	5	0

Tensile Test.

6. A Standard Test Piece **C** or **D** (*see* Appendix, page 37), machined cold from one end of each Axle tested as above, must show a tensile breaking strength of 35 to 40 tons per square inch, with an elongation of not less than 25 per cent. with 35 tons and 20 per cent. with 40 tons; the sums of the intermediate tensile breaking strengths and corresponding elongations being not less than 60.

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* In cases where the length of the Axle does not permit of these distances being adhered to, the distance between the points of support shall be as great as possible.

The yield point* must be not less than 50 per cent. of the ultimate tensile strength.

Cold Bend Test.

7. A test piece 9 inches long and $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, must withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture.

N.B.—This test will be taken only when a less number than 15 Axles are ordered and the falling weight test (Clause 5) has not been carried out.

Additional Tests before Rejection.

8. In the event of the Axle selected for testing not satisfying the requirements of the tensile or bend tests, and the fractured test piece indicating that the result does not fairly represent the bulk of the Axles, the representative of the Engineer (or of the Purchaser) may at his discretion, and at the expense of the Manufacturer take two more test pieces from the same Axle for repeating the test under which failure occurred. The Axles will be accepted if the results of the repeat tests are satisfactory.

Should the Axle fail in the falling weight test, the cast which the Axle represents shall be rejected.

Independent Tests.

9. If the Engineer (or the Purchaser) desires to make independent tensile or other tests of the material, the broken pieces of any of the Axles tested shall be placed at his disposal for the purpose, free of charge.

Re-heating or Oil-Treating.

10. All Axles shall be either re-heated or oil-treated.

Inspection.

11. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

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* The yield point shall, for the purpose of this specification, be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which, when the load is increased at a moderately fast rate, there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Testing Facilities.

12. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No.	**24**
Specification No.	**3-1911**

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
CARRIAGE AND WAGON AXLES.
(WITH ANALYSIS.)
(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Axles shall be manufactured from the highest quality of Steel made from the best selected material by the Acid Open Hearth process, and must not show on analysis more than 0·035 per cent. of Sulphur or of Phosphorus.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Axles must be free from defects of any kind and accurately finished to the prescribed dimensions.

Branding.

3. The Axles shall be distinctly stamped when hot, as far from the centre as practicable, with such brands as the Engineer (or the Purchaser) may require, and in such a manner that these marks shall be legible when the Axles are worn out. When Axles are machined the brands shall be re-stamped cold on one end.

Mechanical Tests.

4. Extra Axles for testing in the manner described in Clauses 5, 6, or 7 shall be provided by the Manufacturer, at his own expense, at the rate of two per cent. of the Axles ordered under the contract, but, except as provided below, one extra Axle shall be provided from each cast of 50, or two axles when a cast consists of more than 50, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Axles as he may think proper to the extent of such percentage or extra number. The Axles tested shall be held to represent correctly the quality of the casts from which they were made. In the case of a less number than 15 Axles being asked for under the contract, or less than 15 being made from each cast, the Manufacturer may either (1) provide an extra Axle for testing, or (2) leave a piece on each Axle of the same diameter as the forged end of the Axle, to enable the representative of the

Engineer (or of the Purchaser) to stamp one such piece from which test pieces may be cut for the tensile test and cold bend test specified in Clauses 6 and 7. After selection of Axles for testing each test Axle must comply with the following tests, without further re-heating or any other manipulation whatever, either of the Axles selected for testing, or of any portion cut therefrom to furnish the test pieces.

Falling Weight Test.

5. The Axle shall be placed upon bearings resting on a block of metal of not less than 5 tons weight supported on a rigid concrete or other solid foundation, and must withstand, without fracture, five blows from a falling weight of 2,240 lbs., as specified below.

The Axle shall be turned after the first and third blow, and shall be broken in the centre after testing.

Diameter of Axle at centre.	Number of Blows.	Height of Fall, in Feet.	Distance between Points of Support.*	
			Ft.	ins.
Under 3¾ inches	5	15	3	0
3¾ ins. and under 4 ins. ...	5	16	3	0
4 ins. and under 4¼ ins. ...	5	18	3	6
4¼ ins. and under 4½ ins. ...	5	20	3	6
4½ ins. and under 4¾ ins. ...	5	20	3	6
4¾ ins. and under 5 ins. ...	5	24	3	6
5 ins. and under 5¼ ins. ...	5	24	4	0
5¼ ins. and under 5½ ins. ...	5	28	4	0
5½ ins. and under 5¾ ins. ...	5	28	4	6
5¾ ins. and under 6 ins. ...	5	32	4	6
6 ins. and over	5	35	5	0

Tensile Test.

6. A Standard Test Piece **C** or **D** (*see* Appendix, page 37), machined cold from one end of each Axle tested as above, must show a tensile breaking strength of 35 to 40 tons per square inch, with an elongation of not less than 25 per cent. with 35 tons and 20 per cent. with 40 tons; the sums of the intermediate tensile breaking strengths and corresponding elongations being not less than 60. The yield point* must be not less than 50 per cent. of the ultimate tensile strength.

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* In cases where the length of the Axle does not permit of these distances being adhered to, the distance between the points of support shall be as great as possible.

Cold Bend Test.

7. A test piece 9 inches long and $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, must withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture.

N.B.—This test will be taken only when a less number than 15 Axles are ordered and the falling weight test (Clause 5) has not been carried out.

Additional Tests before Rejection.

8. In the event of the Axle selected for testing not satisfying the requirements of the tensile or bend tests, and the fractured test piece indicating that the result does not fairly represent the bulk of the Axles, the representative of the Engineer (or of the Purchaser) may at his discretion and at the expense of the Manufacturer take two more test pieces from the same Axle for repeating the test under which failure occurred. The Axles will be accepted if the results of the repeat tests are satisfactory.

Should the Axle fail in the falling weight test, the cast which the Axle represents shall be rejected.

Independent Tests.

9. If the Engineer (or the Purchaser) desires to make independent tensile or other tests of the material, the broken pieces of any of the Axles tested shall be placed at his disposal for the purpose, free of charge.

Re-heating or Oil-treating.

10. All Axles shall be either re-heated or oil-treated.

Inspection.

11. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

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* The yield point shall for the purpose of this Specification be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Testing Facilities.

12. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No. 24

Specification No. 3a-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
CARRIAGE AND WAGON AXLES.

(WITHOUT ANALYSIS.)

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Axles shall be manufactured from the highest quality of Steel made from the best selected material by the Acid Open Hearth or the Acid Bessemer process.

Freedom from Defects.

2. The Axles must be free from defects of any kind and accurately finished to the prescribed dimensions.

Branding.

3. The Axles shall be distinctly stamped when hot, as far from the centre as practicable, with such brands as the Engineer (or Purchaser) may require, and in such a manner that these marks shall be legible when the Axles are worn out. When Axles are machined the brands shall be re-stamped cold on one end.

Mechanical Tests.

4. Extra Axles for testing in the manner described in Clauses 5, 6, or 7 shall be provided by the Manufacturer, at his own expense at the rate of two per cent. of the Axles ordered under the contract, but, except as provided below, one extra Axle shall be provided from each cast of 50, or two Axles when a cast consists of more than 50, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Axles as he may think proper to the extent of such percentage or extra number. The Axles tested shall be held to represent correctly the quality of the casts from which they were made. In the case of a less number than 15 Axles being asked for under the contract, or less than 15 being made from each cast, the Manufacturer may either (1) provide an extra Axle for testing, or (2) leave a piece on each Axle of the same diameter as the

Reference to be quoted.

Report No. 24

Specification No. 3a-1911

forged end of the Axle, to enable the representative of the Engineer (or of the Purchaser) to stamp one such piece from which test pieces may be cut for the tensile test and cold bend test specified in Clauses 6 and 7. After selection of Axles for testing each test Axle must comply with the following tests, without further re-heating or any other manipulation whatever, either of the Axle selected for testing or of any portion cut therefrom to furnish the test pieces.

Falling Weight Test.

5. The Axle shall be placed upon bearings resting on a block of metal of not less than 5 tons weight supported on a rigid concrete or other solid foundation, and must withstand, without fracture, five blows from a falling weight of 2,240 lbs., as specified below.

The Axle shall be turned after every blow, and shall be broken in the centre after testing.

Diameter of Axle at centre.	Number of Blows.	Height of fall, in feet.	Distance between Points of Support.*	
			Ft.	Ins.
Under 3¾ inches	5	15	3	0
3¾ ins. and under 4 ins. ...	5	15	3	0
4 ins. and under 4¼ ins. ...	5	18	3	6
4¼ ins. and under 4½ ins. ...	5	18	3	6
4½ ins. and under 4¾ ins. ...	5	20	3	6
4¾ ins. and under 5 ins. ...	5	20	3	6
5 ins. and under 5¼ ins. ...	5	22	3	6
5¼ ins. and under 5½ ins. ...	5	24	3	6
5½ ins. and under 5¾ ins. ...	5	26	3	6
5¾ ins. and under 6 ins. ...	5	28	4	0
6 ins. and over	5	30	4	0

Tensile Test.

6. A Standard Test Piece **C** or **D** (*see* Appendix, page 37), machined cold from one end of each Axle tested as above, must show a tensile breaking strength of 35 to 40 tons per square inch, with an elongation of not less than 25 per cent. with 35 tons and 20 per cent.

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* In cases where the length of the Axle does not permit of these distances being adhered to, the distance between the points of support shall be as great as possible.

with 40 tons; the sums of the intermediate tensile breaking strengths and corresponding elongations being not less than 60. The yield point* must be not less than 50 per cent. of the ultimate tensile strength.

Cold Bend Test.

7. A test piece 9 inches long and $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, must withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture.

N.B.—This test will be accepted when a less number than 15 Axles is ordered and the falling weight test (Clause 5) has not been carried out, but when a greater number than 15 Axles is ordered, and there is any question in the mind of the representative of the Engineer (or of the Purchaser) as to the Axle having satisfactorily passed the falling weight test, he may at his option have a bend test taken in addition to the falling weight test.

Additional Tests before Rejection.

8. In the event of the Axle selected for testing not satisfying the requirements of the tensile or bend tests, and the fractured test piece indicating that the result does not fairly represent the bulk of the Axles, the representative of the Engineer (or of the Purchaser) may at his discretion, and at the expense of the Manufacturer, take two more test pieces from the same Axle for repeating the test under which failure occurred. The Axles will be accepted if the results of the repeat tests are satisfactory.

Should the Axle fail in the falling weight test, the cast which the Axle represents shall be rejected.

Independent Tests.

9. If the Engineer (or the Purchaser) desires to make independent tensile or other tests of the material, the broken pieces of any of the Axles tested shall be placed at his disposal for the purpose, free of charge.

Re-heating or Oil-treating.

10. All Axles shall be either re-heated or oil-treated.

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* The yield point shall for the purpose of this Specification be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Inspection.

11. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

Testing Facilities.

12. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Conversion Table.

Tons.	Pounds.	Tons.	Pounds.
17	38,080	44	98,560
18	40,320	45	100,800
19	42,560	46	103,040
20	44,800	47	105,280
21	47,040	48	107,520
22	49,280	49	109,760
23	51,520	50	112,000
24	53,760	51	114,240
25	56,000	52	116,480
26	58,240	53	118,720
27	60,480	54	120,960
28	62,720	55	123,200
29	64,960	56	125,440
30	67,200	57	127,680
31	69,440	58	129,920
32	71,680	59	132,160
33	73,920	60	134,400
34	76,160	61	136,640
35	78,400	62	138,880
36	80,640	63	141,120
37	82,880	64	143,360
38	85,120	65	145,600
39	87.360	66	147,840
40	89,600	67	150,080
41	91,840	68	152,320
42	94,080	69	154,560
43	96,320	70	156,800

NOTE.—1 Ton = 2,240 lbs.

APPENDIX.

FORMS

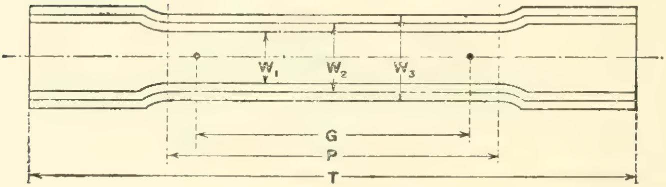
OF

BRITISH STANDARD TENSILE TEST PIECES.

APPENDIX.

FORMS
OF
BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

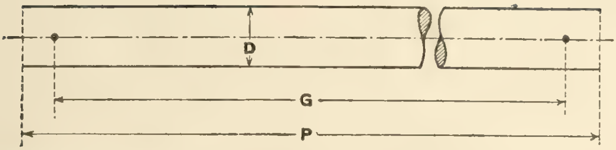


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches.
Total Length **T** = About 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.).	$\mathbf{W_1} = 1\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in. (0·875 in.).	$\mathbf{W_2} = 2$ ins.
Under $\frac{3}{8}$ in. (0·375 in.).	$\mathbf{W_3} = 2\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of 2 inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones; with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard test piece of form **A.**

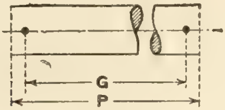
TEST PIECE B.



Gauge Length **G** to be not less than 8 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less
than 9 times the reduced diameter **D.**

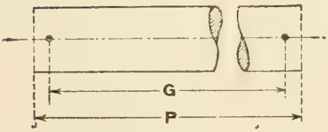
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A,** 8 inches in gauge length, 2 inches wide and $\frac{3}{8}$ inch thick.

TEST PIECE C.



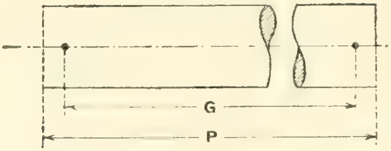
Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than $2\frac{1}{4}$ inches.
Dia. = 0·564 inch.
Area = $\frac{1}{4}$ sq. inch.

TEST PIECE D.



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than $3\frac{3}{8}$ inches.
Dia. = 0·798 inch.
Area = $\frac{1}{2}$ sq. inch.

TEST PIECE **E.**

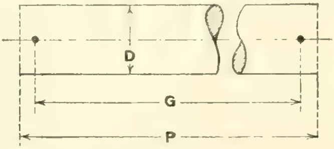


Gauge Length **G** = $3\frac{1}{2}$ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = $\frac{3}{4}$ sq. inch.

Test pieces **C, D,** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either $\frac{1}{4}$ square inch or $\frac{1}{2}$ square inch in sectional area. With the gauge lengths decided upon these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard test piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less than $4\frac{1}{2}$ times the reduced diameter **D.**

In some testing machines it was found inconvenient to use form **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with test piece **F** is greater than with test piece **B;** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS.

In the case of the round test pieces **B, C, D, E** and **F,** the form of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

PRICE LIST
OF
BRITISH STANDARD SPECIFICATIONS AND REPORTS.
NOVEMBER, 1919.

(This List cancels all previous Lists.)

NOTE.—*A number of the Publications of the Association are being issued in French, Italian, Spanish and Portuguese. The majority of the English Editions and all the Foreign Translations (which also include the English text) are being published in octavo form, and will be available at* 1/- *net per copy or its equivalent in Foreign moneys.*

Report No.		Net.	Post free.
1-1919.	**Rolled Sections for Structural Purposes,** Lists of	1/-	1/2
2-1903.	**Tramway Rails and Fishplates,** Specification and Sections of	1/-	1/3
3-1903.	**Influence of Gauge Length and Section of Test Bar on the Percentage of Elongation,** Report on, by Professor W. C. UNWIN, F.R.S.	1/-	1/2
7-1919.	**Copper Conductors, Insulated Annealed,** for **Electric Power** and **Light,** Dimensions of...	1/-	1/2
8-1904.	**Tramway Poles,** Specification for Tubular	1/-	1/2
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